FY-2006-07 PROPOSED SCOPE OF WORK for: **Project #:** 85F
Gunnison and Green River Sediment Monitoring

Lead Agency: U.S. Fish and Wildlife Service

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Category:
X Ongoing project
_ Ongoing-revised project
_ Requested new project
_ Unsolicited proposal

Expected Funding Source:
x Annual funds
_ Capital funds
x Other

I. **Title of Proposal**:

Gunnison and Green River Basin Sediment Monitoring and Evaluation Program Statement of Work for FY 2006 and 2007.

II. Relation to RIPRAP:

General Recovery Program Support Action Plan I.A.3&4
Gunnison River Action Plan: 1.A. Identify fish habitat and flow needs
Green River Action Plan: 1.A. Identify fish habitat and flow needs

III. **Study Background/Rationale and Hypotheses**:

Underlying geomorphic processes relevant to the formation and maintenance of backwater habitats are relatively poorly understood, particularly the effects of peak-flow magnitude and duration; sediment deposition and erosion; base-flow magnitude and variability; and antecedent conditions on habitat availability and conditions. Knowledge of sediment dynamics in important river reaches is critical to understanding the effects of flow regimes on endangered fish habitats.

Based upon a report entitled "Recommended Priorities for Geomorphology Research in Endangered Fish Habitats of the Upper Colorado River Basin" (LaGory et.al, 2003), the Recovery Program requested proposals to conduct the sediment monitoring element of a Connected Backwaters Project, which also includes a physical habitat monitoring element involving topographic measurements of selected backwaters and adjacent exposed sandbars in each of six river reaches. After review by the geomorphology peer review panel and the Biology Committee, this physical habitat-monitoring element of the project was deferred. However, installing and operating sediment samplers in conjunction with existing streamflow gages were found to be important to supplement and expand existing sediment knowledge.

Beginning in 1998 the Recovery Program and USGS began a 5-year program of sediment data collection for the Yampa and Green Rivers (Elliot and Anders, 2004). Included in Elliot and Anders are sediment-transport equations for suspended load, bedload, total-sediment load, and total-sediment load by hydrograph season. For example, 40 suspended-sediment and 40 bedload measurements were made at the Green River near Jensen, Utah, at discharges ranging from 965 ft^3/s to 22,000 ft^3/s. These data included 18 measurements during the rising-limb hydrograph season and 18 measurements during the recessional- or falling-limb hydrograph season.

While periodic sediment-transport data have been collected and sediment-transport equations adequate for sediment-budget estimation have been derived for the Green River near Jensen (Elliott and Anders, in review) no daily-sediment data have been collected. Collection of daily sediment records and associated suspended-sediment size analysis can be used to provide the basis for comparison of sediment loads computed using daily samples and sediment loads computed using the sediment-transport equations of Elliott and Anders (2004). Their sediment-transport equations are based on periodic sediment data and represent average sediment-transport conditions in a river. The average condition defined by the equations may not adequately represent episodic sediment transport and sediment concentrations that occur before or after the snowmelt hydrograph. Sediment transport characteristics in the Green River during periods of early snowmelt runoff and during rainfall runoff are usually not well defined by the average condition represented by the sediment-transport equations. The collection of daily sediment records and analysis of the distinction between sediment records computed using the two methods would be an important guide in determining sediment data collection needed to support instream habitat considerations. In addition, collection of daily suspended-sediment data and the associated periodic sediment samples will be useful to improve existing sediment equations by supplementing existing periodic-sampling data.

Based upon a cursory review of existing Gunnison River data sources by Pitlick and others (1999), sediment data comparable to that available for the Green River at Jensen are not available for the Gunnison River near Grand Junction (here in after called the Whitewater gage). The sediment data available for the Whitewater gage are limited to periodic suspended-sediment concentrations collected between 1959 and 1999. A limited amount of sediment-size data, mostly percent of sample finer than 0.062 millimeters, is available at

this site. Therefore the development of sediment-transport equations similar to those developed for the Green River near Jensen would be limited to suspended sediment concentration and perhaps percent of sample finer than 0.062 millimeters. Adequate sediment-size data are needed to develop sediment-transport equations for various sediment-size classes. Similar to the Green River near Jensen, the collection of daily sediment records and the development of sediment-transport equations will allow for analysis of the differences between sediment records computed using each method and would be an important guide in determining sediment data collection needed to support instream habitat considerations. The Green River near Jensen represents sand-sized bed sediment and the Whitewater gage represents mostly cobble-sized bed sediment. No bedload samples have been colleted at the Whitewater gage. Bedload discharge will, in lieu of the collection of bedload samples, be estimated for the Whitewater gage using published empirical sediment-transport equations (Einstein, 1950).

Based upon discussion with the Biology Committee, Argonne National Laboratory, and other interested individuals, the USGS was requested to submit a proposal to implement sediment sampling at two locations believed to be important to support future habitat monitoring work and to address key uncertainties in existing flow recommendations for the Green and Gunnison Rivers. The two locations are 09152500 Whitewater gage (0.5 miles south of the town of Whitewater, Colorado on the Gunnison River) and 09261000 Green River near Jensen, Utah.

IV. Study Goals, Objectives, End Products:

A. Goals:

The goal of the sediment monitoring program is to provide information with which to evaluate changes in the magnitude, timing, and size distribution of sediment delivery to the Gunnison and Green River systems and their potential effects on the riverine ecosystem, specifically as they relate to recovery of the endangered fishes.

B. Objectives:

The primary objective of this sediment-monitoring project is to address key uncertainties in priority reaches of the Colorado, Gunnison and Green Rivers relevant to the role of streamflow and sediment transport on the formation and maintenance of backwater habitats and spawning bars[1]. A secondary objective is to collect necessary sediment data to aid in the evaluation of Service flow recommendations for the Aspinall Unit and Flaming Gorge Reservoir.

[1] While spawning bars were not emphasized by decision makers in 2003 they were ranked high in the priorities report LaGory 2003 and data collection to address spawning bar issues need to be collected simultaneously with data needed for backwater habitat studies.

1. A retrospective analysis of historic sediment data will be done to determine the availability of historic sediment data for the key sites on the Colorado, Gunnison, and Green River near Green River Utah. This objective also includes an evaluation of the data to determine their utility for developing sediment-transport equations **(These were completed and presented at the habitat workshop in March 2005).** In addition, an evaluation of trends in sediment transport, and how variations (wet vs. dry years) in annual hydrographs affect sediment transport will be included in the SIR **(to be written in FY 2008)**.

2. To support the evaluation of the effects of streamflow and sediment movement on the morphometric and bed material characteristics of Gunnison and Green River.

3. Determine if there is any distinction between sediment load estimates computed from daily sediment data, sediment transport equations, and empirical bedload transport equations.

4. Evaluate the dynamics of sediment movement in the study reaches by collecting and analyzing data to compute sediment load, including suspended sediment using daily samples and sediment transport equations. Water-surface slope and bed-material samples will be collected at two sites to support bedload calculations. These data will be collected at the Whitewater gage and the Green River near Jensen Utah (Jensen). These sites represent the range in sediment conditions found in other habitat monitoring reaches (primarily cobble bottom in the Gunnison R. at Whitewater and a sand cobble mixture, primarily sand, found in the Green R. near Jensen).

5. Collect necessary topology data near the Jensen site for use in a Surface Water Modeling System (SWMS) Demonstration Project to determine the suitability of this type of modeling of sediment transport as it relates to current and future efforts to monitor habitat for the endangered fishes. An added utility of the proposed work is the opportunity, at a later date, to incorporate output from the SMWM into existing habitat models to further relate streamflow and sediment transport to recovery efforts for the endangered fishes.

V. End Product:

The end products of this Scope of work will be reports prepared by the USGS. The priority will be to prepare annual progress reports to the Recovery Program that will contain the data retrospective, annual data record summaries and in the third year preliminary sediment equations that can be used for data points for the habitat monitoring program. After the third year of data collection, in Fiscal Year 2008, the USGS will prepare a Scientific Investigations Report that summarizes the retrospective analysis of sediment data for the Green and Gunnison Rivers. This analysis will include sediment-transport equations, trend analysis, and hydrologic analysis developed using historic data. In addition, the report will evaluate the results of sediment-transport calculations derived using daily and periodic sediment samples (sediment-transport equations). This analysis will be done in concert

with stream habitat professionals to determine what types of sediment-transport data support planned habitat evaluation on the Green and Gunnison Rivers. From that analysis, a sediment data-collection network will be designed and proposed. This approach will ensure that sediment data are collected in the most cost-efficient manner to support habitat investigations.

An expert panel should be assembled by the RIP to review the results of objective 1 & 2 and review the state of current knowledge relating to how sediment data can be related to the creation and maintenance of backwaters habitats. (This panel to be setup separates from this scope of work by Recovery Program staff and will use a separate funding source to pay contributors).

Under the current scope of work for the SWMS demonstration project, plans for publication will be made depending on preliminary results following the completion of the SWMS model in early Fiscal Year 2007. Funding for further analysis and publication will be determined at that time and will vary depending on the scope.

VI. Study Method/Approach:

A retrospective analysis of historic sediment data will be done for the key sites on the Colorado, Gunnison, and Green River near Green River, Utah. This analysis will determine whether sediment-transport relations can be derived from existing data and what if any additional data may be needed to develop or improve sediment transport equations at these sites. Also, historic data will be evaluated to determine if significant trends exist in sediment transport, and the effect of variations in annual hydrographs (wet vs. dry years) on sediment transport.

This project will establish automated suspended-sediment samplers in two critical reaches of the Upper Colorado River Basin (Whitewater gage on the Gunnison River and the Green River near Jensen, Utah). Daily suspended-sediment load data at these two sites will provide information needed for: (1) an understanding of sediment budgets (sediment import and export balance); (2) the effects of flow regime on habitat maintenance; (3) the relationship between sediment load and streamflow, including base and peak flows; (4) the effects of antecedent conditions (if the right sequence of years is present) on sediment transport; and (5) the effect of peak-flow duration on sediment transport rates.

The SWMS Demonstration will be done through the collection and development of a topological dataset using advanced GPS mapping and Acoustic Doppler Current Profiler (ADCP) bathymetry. The topological dataset, in conjunction with available sediment data, will be used in the SWMS model for a reach of the Green River (near the Green River near Jensen streamflow-gaging station, 09261000) to allow for the hydraulic simulation of sediment-transport and channel-morphologic response to user-defined streamflow conditions.

VII. Task Description and Schedule

1. **Retrospective Analysis of Historic Data (completed in FY 2005):** Sediment data for the Colorado River in the vicinity of the 15-mile and 18-mile reaches of the Colorado River in the Grand Valley and downstream to the confluence of Green River, the Gunnison River downstream from the confluence of the North Fork of the Gunnison River, and the Green River near Green River, Utah will be summarized. These data will be used to develop sediment-transport equations, to the extent possible, similar to those developed for the Yampa River, Little Snake River, and the Green River near the Gates of Lodore and the Green River near Jensen, Utah. Trends will be determined at sites where data are adequate for that purpose. Also, the effects of the annual streamflow hydrograph on sediment transport will be evaluated. These analyses will help to identify data gaps that would be addressed by sediment sampling done in the support of habitat evaluations.

2. **Site Installation (completed in FY 2005) and Data Collection (FY 2005-07):** The USGS Grand Junction office will be contracted to install and instrument two automatic sediment collection sites. The collection of daily suspended-sediment records will be during mid-March through mid-October (approximately 7 months). These data will be collected at the following USGS gage sites:

09152500 Gunnison River near Grand Junction (also known as the Whitewater gage), Colorado
09261000 Green River near Jensen, Utah.

During Water Year 2006 and 2007 data collected at the sites on the Gunnison and Green Rivers will include:

1. Continue to collect data needed for calculation of a daily sediment record at the Gunnison River near Grand Junction, Colorado and the Greene River near Jensen, Utah. Daily sediment records will be collected for 7 months (March through October). Point samples for suspended sediment are collected using automatic samplers. The sampling equipment will be operated to capture the entire snowmelt runoff period, as well as any major sediment transport (i.e., rainstorm events) events in summer and fall. A turbidity sensor will trigger sampling during such events. In addition, during site visits temperature and specific conductivity will be measured.

2. Collection of depth- and width- integrated suspended-sediment samples for calibrating the point sample to the stream cross section concentrations (7-10 samples at each site).

3. About 25 percent of the automated point samples will be analyzed for suspended-sediment concentration and percent of sample that is silt and clay and the percent of sample that is sand. Suspended-sediment concentration will only be determined for the balance of the point samples.

4. Water-surface slope will be measured for incipient motion calculations for estimating the threshold for entrainment of bottom material at various streamflows.

5. Bed-material samples and depth- and width- integrated suspended-sediment samples for full-size analysis will be collected at each site for use in the modified Einstein method, which will be used to estimate bed-load transport. Because the Einstein method might not work at the Whitewater gage because the bed is mostly cobble, there might be a need to use a different methodology such as the Meyer-Peter Muller or Parker equations. These data will provide perspective regarding percent of the total sediment load represented by bedload. Estimates of bedload and corresponding calculations of critical shear stress, threshold of sediment movement (maximum grain size entrained for a given streamflow), will provide information to characterize bed-sediment entrainment and bed-load sediment transport over a range of streamflows. This analysis would provide guidance for planning if sampling of bedload in subsequent years is determined to be needed.

Schedule: It is anticipated that the sediment sampling will be for 3 years (sampling began in Water Year 2005) with the data summarized and interpreted in a USGS report after the third year of data collection. A preliminary data retrospective will be completed in the first 12 months of the study. The preliminary retrospective analysis was completed for the habitat workshop held in Denver March 4, 2004.

3. **Surface Water Modeling System (SWMS) Topology and Model Demonstration (completed by early FY 2007):** To address the issue of endangered fish habitat, the USGS will develop a topological dataset and water-level elevation dataset sufficient for input into the Surface Water Modeling System (SWMS) and use of the SWMS for hydraulic simulation of sediment-transport and channel-morphologic response to user-defined streamflow conditions. A preliminary analysis of this model will be completed to demonstrate the utility of SWMS and a sediment mobility model solution will be created to aid the U.S. Fish and Wildlife Service (USFWS) in the evaluation of Service flow recommendations for the Flaming Gorge Reservoir, as they relate to recovery efforts for the endangered fishes.

VIII. FY-2006 to 2008 Budget Estimate:
FY2006 Budget Detail

FY 2006 Costs:

	Agency	Total	Comments
Task 1 - Program Management			
Proj. mgr GS-9 ($29.43/hour; 240hours)	$7,060	$7,060	
Task subtotal		**$7,060**	
Task 2 - Data Collection and Record Computation			
Hydrologist GS-9 ($29.43/hour; 5500 hours)	$16,186	$16,186	
Technician GS-11 (40/hour; 88 hours)	$3,531	$3,531	
Technician GS- 5 ($16.2/hour; 340 hours)	$5,508	$5,508	
Travel 25 days at $91/day	$2,275	$2,275	
Shipping	$2,650	$2,650	
Sediment Laboratory	$12,420	$12,420	Cost for sediment analysis: concentration 700 samples, sand-break 400 samples, full-size 50 samples, bottom material 4.
Supplies	$3,700	$3,700	turbidity standards, nozzles, gaskets, samplers, etc.
Vehicle 30 days at $100/day	$3,000	$3,000	
Subtotal		**$49,270**	
Task 2 -Computation of Bedload			
Hydrologist GS-9 ($29.43/hour; 280 hours)	$8,240	$8,240	
Res. Hydrologist GS-13 ($59.40/hour; 100)	$5,940	$5,940	
Technician GS- 5 ($16.2/hour; 150)	$2,430	$2,430	
Subtotal		**$16,610**	
FY 2006 TOTAL		**$72,940**	
Science Center Overhead 16.7%	$12,181	$12,181	
Headquarters Assessment 12%	$8,753	$8,753	
Facilities Assessment 12.174%	$8,880	$8,880	
Science Support 36%	$26,258	$26,258	
Task 3 –Surface Water Modeling System			
Hydrologist GS-9 ($28.8/hour; 150 hours)	$4,300	$4,300	
Technician GS-11 ($38/hour; 50 hours)	$1,900	$1,900	
Technician GS- 7 ($27.5/hour; 120 hours)	$2,750	$2,750	
Travel 20 days at $100/day	$2,000	$2,000	
Shipping	$1,500	$1,500	
Sediment Laboratory	$3,000	$3,000	
Supplies	$4,500	$4,500	
Vehicle 10 days at $165/day	$1,650	$1,650	
Task subtotal		$21,600	
Task subtotal with overhead		**$40,000**	
TOTAL		**$169,012**	Use 169,000

FY2007 Cost estimate for sediment sampling at 2 sites and preparation of annual progress report:
BOR 135,500

FY2008 Cost estimate for Scientific Investigations Report:
BOR 95,000

IX. FY2006 Funding

Funding Source	FY2006 Total
Argonne National Laboratory	$15,000
Recovery Program (BOR)	$117,000
Recovery Program (Wyoming)	$24,000
USGS COOP	$13,000
Total	$169,000

X. Literature Cited:

Elliott, J.G., and Anders, S.P., 2004, Summary of sediment data from the Yampa River and upper Green River basins, Colorado and Utah, 1993-2002, U.S. Geological Survey Scientific-Investigations Report 2004-5242, 35p.

Einstein, H.A., 1950, The bedload function of sediment transportation in open channel flows, USDA Technical Bulletin 1026.

Kirk E. LaGory, John W. Hayse, and David Tomasko, 2003. Recommended priorities for geomorphology research in endangered fish habitats of the upper Colorado River basin.

McAda C. W., 2003, Flow recommendations to benefit endangered fish in the Colorado and Gunnision Rivers. U.S. Fish and Wildlife Service Recovery Program Project Number 54 Final Report July, 2003.